RESEARCH PLAN

ON

MODELING ENERGY EFFICIENT SECURE COMMUNICATION IN UNDERWATER WIRELESS SENSOR NETWORKS

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INTRODUCTION

Wireless Sensor Networks (WSNs) being a major part of communication have a wide research scope. A Wireless Sensor Network consists of a number of miniature sized electronic devices known as sensors or nodes, deployed in a geographical region. Each such device in the network is capable of sensing, processing and communicating the data from the area in which it is deployed. These electronic devices forming the network transmit the sensed information to the Base Station (BS) or a common sink. Data can be sent directly to the sink node or it can be transmitted using a gateway or some relay node [1] as shown in Figure1.

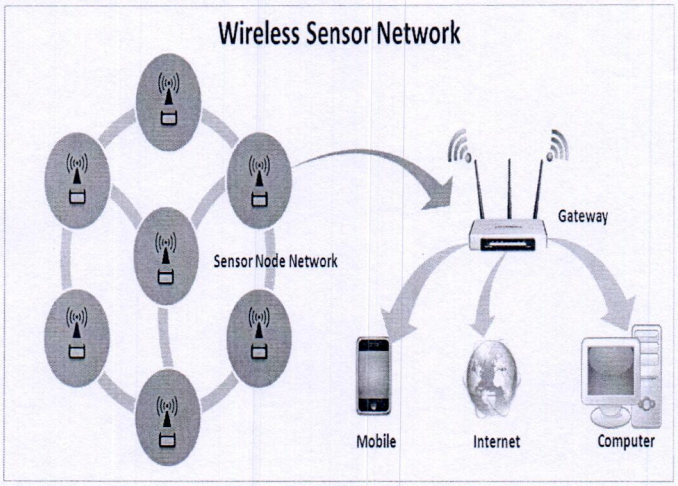

Figure 1. Basic Wireless Sensor Network Arrangement

Broadly, the types of the Wireless Sensor Networks include: Terrestrial Wireless Sensor Networks, Underwater Wireless or Acoustic Sensor Networks, Multimedia Wireless Sensor Networks, Mobile Wireless Sensor Networks, Body Area Wireless Sensor Networks [1,2].

As we know Earth being a water planet, covering 70 percent of surface with water, offers an opportunity to attract the researchers because of the large unexplored area. The areas include monitoring of marine and aquatic life, pollution, oil and gas reserves, seismic activities etc. All these important applications, call for the need of building Underwater Wireless Sensor Networks (UWSN)[3]. An Underwater Wireless Sensor Network can be defined as a group of sensors deployed under the water and networked through acoustic links, performing collaborative tasks[4].

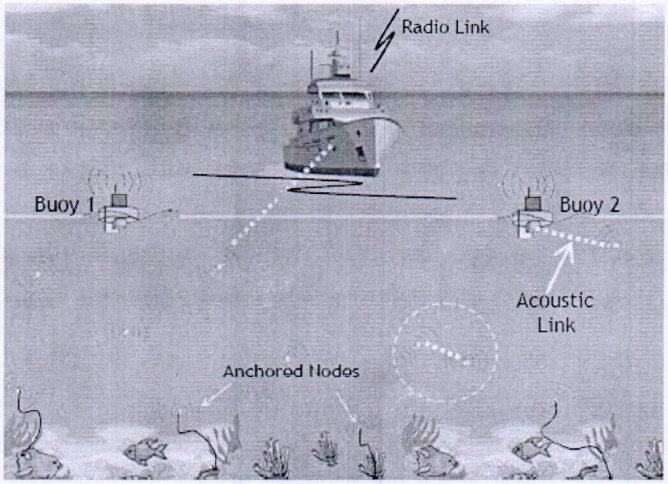

Figure2. Underwater Wireless Sensor Network

Figure2 shows the basic scenario of Underwater Wireless Sensor Network, having nodes or sensors deployed at the bottom or at different depths of the sea, responsible for sensing, processing and communicating the events from the water ambience to the sink or the base station located on the surface.

There have been several research routed towards Terrestrial Wireless Sensor Networks, but there are also some important applications like offshore oil field monitoring, pollution detection, oceanographic data collection and many more, which call for the need of building underwater sensor network and enhance our ability to observe and predict the ocean. Studies have progressed significantly to find method to support the development of energy efficient protocols in Terrestrial Wireless Sensor Network. However, most of such methods are not directly applicable in underwater sensor networks area. Research efforts are open in this area for creating the protocols which are energy efficient for underwater sensor networks [5].

Earth having 70% of water, gives a lot of opportunity to explore the field of water. The area of Underwater Wireless Sensor Networks being a less unexplored field, offers a variety of research options. But as less worked upon, it has numerous challenges with it, due to not so convenient environment to deal with. UWSNs offers a large number of applications, facing the issues like limited bandwidth, energy conservation, mobility, attenuation, path loss, propagation speed, noise and most importantly security [6].

Reliability and robustness of underwater communication link is greatly affected by the environment. Variations in pressure, salinity, ocean currents, marine life etc. create significant variations in link reliability. The reasons behind the degradation of underwater sensor networks, including the natural causes and the types of hostile attacks and the measures that can be applied to improve security in Underwater Wireless Sensor Networks [7,8] will be studied.

BACKGROUND AND SIGNIFICANCE

Earth is a water planet. The surface of Earth is occupied largely by water and provides opportunities for exploration in this vast unexplored area. There is the need of Underwater Wireless Sensor Networks (UWSNs), a category of Wireless Sensor Networks, in which a group of sensors are deployed underwater and networked via acoustic links, for performing collaborative tasks in the applications like water quality analysis, underwater monitoring, oceanographic data collection, offshore oil filed monitoring, aquatic life monitoring, surveillance monitoring, environmental monitoring, disaster prevention etc [6]. But as less worked upon, it has numerous challenges with it, due to not so convenient environment to deal with. UWSNs offering such a variety face the issues like limited bandwidth, energy conservation, mobility, attenuation, path loss, propagation speed, noise and most importantly security [9]. This proposal first of all will give an analysis of all these issues concerning the medium of communication. The work will help in developing the energy efficient network model for Underwater Wireless Sensor Networks for 2D and 3D architectures. Further, it will lead to simulating the optimal scenarios for energy efficient secure routing and communication in Underwater Wireless Sensor Networks. The relevance and importance of the research work may be felt from the expected outcomes, mentioned in the last section of the plan.

Keywords: Acoustic channel, Attenuation, Absorption loss, Clustering, Doppler effect, Energy efficiency, Gateways, Noise, Robustness, Topology, Security.

OBJECTIVES OF THE PROPOSED RESEARCH WORK

The proposed research work will involve the following points:

1) Modeling, simulating and comparing the energy efficient network model for underwater wireless sensor networks for 2D and 3D architectures, specifically for the different applications like aquatic life monitoring, water quality analysis, surveillance monitoring, environmental monitoring and disaster prevention.

2) Study and analysis of various characteristics of acoustic channel and their effects on communication in underwater wireless sensor networks. The characteristics include the attenuation, absorption, noise, mobility, doppler effect, sound and wind speed.

3) Energy efficient routing and communication in underwater wireless sensor networks by using the optimal topology or node arrangement in 2D and 3D scenario, applying clustering techniques with optimal selection of cluster heads, use of gateways in an efficient manner, with the aim of increasing the network lifetime by efficiently using the battery and decreasing the communication cost.

4) Applying the security techniques on the routing protocol in underwater wireless sensor networks for secure communication and to prevent the data from being hacked or lost. Moreover, increasing the reliability of the communication and routing in underwater wireless sensor networks.

APPROACH / METHODOLOGY INTENDED TO BE ADOPTED

The proposed work will be conducted on the simulator, MATLAB. It will involve the implementation of various characteristics of acoustic channel and their analysis, 2D and 3D architecture energy efficient network model for Underwater Wireless Sensor Networks, energy efficient optimal scenario and routing technique involving secure communication for the same.

Objective 1: Modeling, simulating and comparing the energy efficient network model for Underwater Wireless Sensor Networks for 2D and 3D architectures.

The architecture usually followed for the Terrestrial Wireless Sensor Networks is two dimensional. But when we move from terrestrial to the underwater sensor networks, there arises a need for three dimensional architecture in majority of applications. Though UWSNs can be deployed in both the 2D and 3D architectures but the applications decide which type of architecture will be more feasible and advantageous. The work may involve developing the models of UWSNs for the following applications:

a) Aquatic Life Monitoring
b) Water Quality Analysis
c) Surveillance Monitoring
d) Environmental Monitoring
e) Disaster Prevention

We need to figure out the modules that each sensor and the network will require for the specific application. Moreover, the network model will include the energy consideration for working.

Objective 2: Analysis of various characteristics of acoustic channel and their effects on communication in Underwater Wireless Sensor Networks.

The medium called water is not as simple as other mediums of communication. Due to not so convenient environment to deal with, underwater networks are affected by various characteristics of acoustic channel. The characteristics include the attenuation, absorption, noise, mobility, doppler effect, sound and wind speed. The effects of all these characteristics and parameters, along with their tradeoffs, cannot be ignored and must be considered while performing communication in Underwater Wireless Sensor Networks. This will be done by implementing the standard equations for the same and varying the dependable parameters to study the desired characteristic.

Objective 3: Energy efficient routing and communication in Underwater Wireless Sensor Networks.

This may be achieved by simulating the different scenarios in order to increase the lifetime of the network, as in the water, the battery replacement of nodes is difficult due to not so easily approachable medium. The following approaches will be followed:

a) Optimal clustering techniques, Cluster head selection and gateways arrangement
b) Nodes arrangement and topology
c) Base Station of Ground Sink position
d) Decreasing the communication cost

Objective 4: Applying the security techniques on the routing protocols in Underwater Wireless Sensor Networks for secure communication.

(a) Study of various attacks, their causes and effects possible in acoustic communication. They may be on the node hardware, communication link or network protocol, either due to environmental or intentional factors or means.
(b) The aim then will be to apply some secure technique i.e. a cryptographic algorithm for establishing reliable routing and delivering secure communication in the Underwater Wireless Sensor Networks.

LIKELY OUTCOME/DELIVERABLES EXPECTED OUT OF THE PROPOSED RESEARCH WORK

An energy efficient optimal network model for secure routing for Underwater Wireless Sensor Networks, in consideration with the acoustic channel characteristics will be the expected outcome of the proposed work.

The proposed research work will be relevant in the following manner:

1) Figuring out which architecture out of 2d and 3D will be more feasible in any specific application when applied to.
2) While implementing the Underwater Wireless Sensor Networks, the characteristics that be analyzed with different tradeoffs will be common for any type of communication in this environment.
3) The different applications may directly use the arrangement of nodes, gateways, clusters, position of sink in an optimal manner.
4) Lastly, there will be help in the surveillance system to detect intrusion from enemies sending of fake or malicious data in the network and invoke secure and reliable communication.

References

[1] Singh, Gurbhej, and Harneet Arora. "Design and Architectural Issues in Wireless Sensor Networks." International Journal of Advanced Research in Computer Science and Software Engineering 3.1 (2013).

[2] Yick, Jennifer, Biswanath Mukherjee, and Dipak Ghosal. "Wireless sensor network survey." Computer networks 52.12 (2008): 2292-2330.

[3] Ayaz, Muhammad, and Azween Abdullah. "Underwater wireless sensor networks: routing issues and future challenges." Proceedings of the 7th International Conference on Advances in Mobile Computing and Multimedia. ACM, 2009.

[4] Jurdak, Raja, and Pullenvale QLD Australia. "Software Driven Underwater Acoustic Sensor Networks." Underwater Acoustic Sensor Networks (2010): 251.

[5] Akyildiz, Ian F., Dario Pompili, and Tommaso Melodia. "State-of-the-art in protocol research for underwater acoustic sensor networks." Proceedings of the 1st ACM international workshop on Underwater networks. ACM, 2006.

[6] Ayaz, Muhammad, et al. "A survey on routing techniques in underwater wireless sensor networks." Journal of Network and Computer Applications 34.6 (2011): 1908-1927.

[7] Davis, Almir, and Hwa Chang. "Underwater wireless sensor networks." Oceans, 2012. IEEE, 2012.

[8] Akyildiz, Ian F., Dario Pompili, and Tommaso Melodia. "Challenges for efficient communication in underwater acoustic sensor networks." ACM Sigbed Review1.2 (2004): 3-8. Heidemann, John, Milica Stojanovic, and Michele Zorzi. "Underwater sensor networks: applications, advances and challenges." Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences370.1958 (2012): 158-175

[9] S. De, P. Mandal, and S. S. Chakraborty, "On the characterization of Aloha in underwater wireless networks," Elsevier J. Mathematical and Computer Modeling, Spl. Issue on Wireless Networks, vol. 53, no. 11-12, pp. 2093--2107, June 2011.